

N71-36857

NASA TECHNICAL TRANSLATION

NASA TT F-13,966

ON TETRAGONAL FERROPLATINUM FROM THE NORIL'SK DEPOSITS

A. D. Genkin and G. V. Basova

**CASE FILE  
COPY**

Translation of "Novyye Dannyye o Mineralakh  
SSSR (New Data on USSR Minerals), Trudy of the  
Mineralogical Museum im. A. Ye. Ferman, Academy  
of Sciences USSR, No. 16, 1965, pp. 209-214

## ON TETRAGONAL FERROPLATINUM FROM THE NORIL'SK DEPOSITS

A. D. Genkin and G. V. Basova

ABSTRACT: The authors conducted chemical and X-ray studies of samples of ferroplatinum found in a chalcopyrite vein in Noril'sk mines. In their study they describe the unique form of ferroplatinum fillings. The chemical analysis of the sample revealed a high content of iron and a close resemblance to the Ural ferroplatinum. An original method of X-ray photography produced sufficiently intense lines and convinced the authors that the mineral under study was ferroplatinum of tetragonal structure.

Along with other elements, native platinum constantly contains iron in the /209\* form of isomorphous impurity. In the most abundant mineral of the platinum group, polyxene, the quantity of iron comprises from 5 to 11%. Other kinds of native platinum with a higher content of iron, up to 16-21%, have received the name of ferroplatinum (Vysotskiy, 1925; Betekhtin, 1935, 1950). A. G. Betekhtin (1950) pointed out that up to that time ferroplatinum was found only in the placer mines of the Ural deposits (of Nizhniy-Tagil district). The ratio Pt:Fe in the Ural ferroplatinum is close to 1:1. Like polyxene, it is of face-centered cubic structure. It has not been studied microscopically in polished sections.

A. Kussman and G. Rittberg (1950) in studying the Fe-Pt system established that alloys in the Fe-Pt range under low temperatures form an ordered phase with the structure of AuCu type belonging to the tetragonal system with  $a = 3.87 \text{ \AA}$  and with the ratio of axes  $c/a = .973$ .

In the X-ray study of schlich platinum from Noril'sk deposits V. I. Mikheyev, A. I. Kalinin and E. P. Sal'dau (1961) in the Debye powder diagrams of electromagnetic and magnetic fractions, represented by the mixture of various minerals, found lines characteristic of ferroplatinum. Regrettably, the optical and chemical study of the minerals was not done.

For comparison with Noril'sk ferroplatinum V. I. Mikheyev and others conducted the X-ray study of a sample of Ural ferrous platinum which is kept in the Mines Museum of the Leningrad Mining Institute under No. 11/28 and they estab-

---

\*Numbers in margin indicate pagination in foreign text.

lished that like the Fe-Pt alloy (Kussman, Rittberg, 1950) it is an ordered phase with tetragonal structure.

We found in the chalcopryrite veins of the Noril'sk deposits a mineral which X-rays determined as close to native platinum, although it differed from it. I. V. Mikheyeva drew our attention to the close resemblance of the Noril'sk mineral to Ural tetragonal ferroplatinum (Mikheyeva et al, 1961.)

#### Discovery Conditions and Properties of Ferroplatinum

Ferroplatinum was found in polished sections from the chalcopryrite vein imbedded in sandstones (Taymyr mine, 203 m horizon). The principal ore minerals of the vein are chalcopryrite and pentlandite which forms in chalcopryrite large (over 1 cm) porphyry-like fillings. As it is observed in some other veins there is a regular association of ferroplatinum and other platinum minerals with the hanging wall of the vein and their disposition along its flucan (Genkin, 1959). /210

Ferroplatinum is found in the midst of chalcopryrite in the form of unique veinlets (Figure 1) up to .1-.15 mm in thickness. The veinlets are characterized by irregular boundaries, sharp decreases in depth, and increases in thickness (Figure 2). The shape of veinlets becomes especially distinct in the process of their preparation in chalcopryrite along the plane. Sometimes they appear to be sufficiently extended and sometimes they consist of separated plates of very peculiar shapes (Figure 3). /211

In the paragenetic association with ferroplatinum there are stannopalladinite, which is still inadequately studied (Maslenitskiy, 1949; Genkin, Korolev, 1961), and which is usually represented in chalcopryrite by grains of round and oval shapes and native gold. Sometimes ferroplatinum is enclosed by border fillings of stannopalladinite (Figure 4). /212

It is interesting that small well-formed crystalline parts of apatite are sometimes located in the sections of the vein adjoining the flucan in which ferroplatinum is found.

Grains of ferroplatinum extracted from a polished section are colored in the range from silvery-white to steel-grey with a strong metallic glitter.

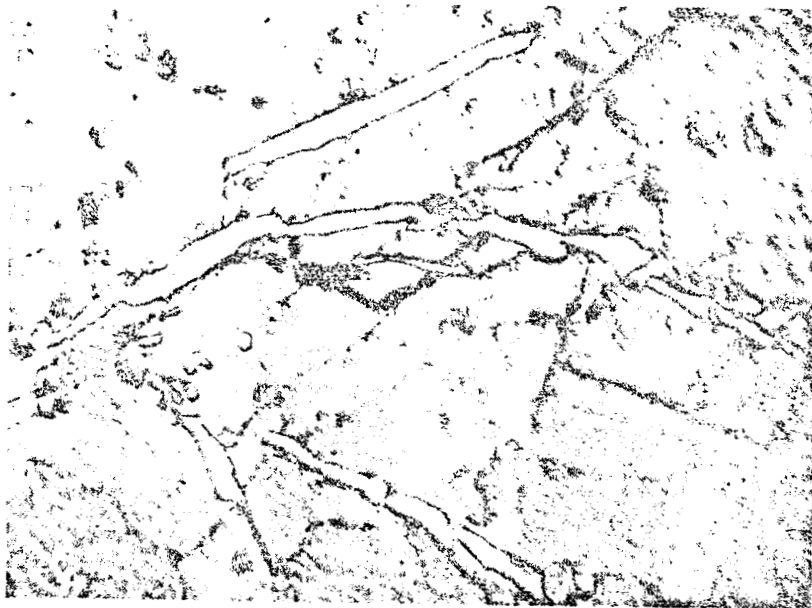


Figure 1. Veinlets of Ferroplatinum (Bright White) In Chalcopyrite (Grey). Polished Section, x 40.



Figure 2. Irregular Forms of the Ferroplatinum Veinlet (White) In Chalcopyrite (Grey). Polished Section, x 165.



Figure 3. The Shape of A Filling of Ferroplatinum Obtained By Dissolving Surrounding Chalcopyrite In Concentrated  $\text{HNO}_3$  x 80.

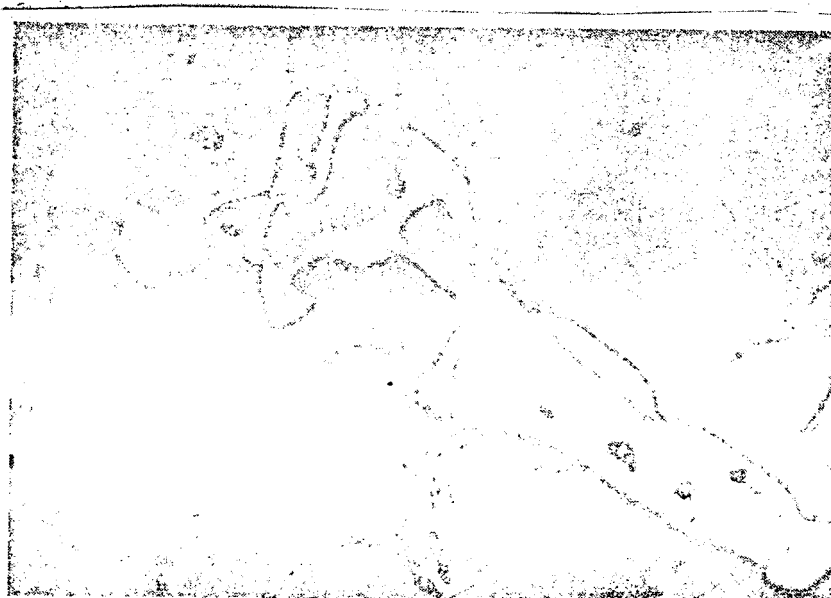


Figure 4. Ferroplatinum (Bright White) In the Form of A Border Surrounds Fillings of Stannopallinite (Grey) In Chalcopyrite (Dark Grey). Polished Section, x 165.

In reflected light the mineral is brilliant white, isotropic. The reflecting power in yellow light is ( $\lambda = 558 \text{ m}\mu$ ) 66%.

Hardness is fairly high, but a steel needle produces lines on the metal.

It is not etched by the usual reagents of diagnostic etching and concentrated acid. It is etched only by aqua regia. A characteristic feature of the mineral is its strong magnetizability.

#### On the Composition of Ferroplatinum

For taking samples of the mineral for chemical analysis its magnetizability and resistance to concentrated nitric acid were utilized. About 30 mg of lamellar formations of ferroplatinum were taken.

The analysis<sup>1</sup> was conducted in two parallel batches weighing 15 and 13 mg in which platinum, iron, and palladium were determined. The batches were decomposed in aqua regia to complete dissolving. The solution was dissolved with water and filtered. The filtrate was evaporated, was converted to chlorides, diluted with water, and platinum and palladium were precipitated from the volume of 100 ml. In the filtrate, iron was determined in the form of  $\text{Fe}_2\text{O}_3$  by precipitation with ammonia. The precipitate of platinum and palladium was treated with aqua regia, converted to chlorides, and palladium was separated from platinum by precipitating palladium with 1% solution of dimethyl glyoxime. In the the filtrate platinum was determined by the precipitation with calomel, calcination, and suspension. The results of ferroplatinum are presented in Table 1.

Table 1: Findings of the Chemical Analysis of Ferroplatinum

Batch	Pt		Fe		Pd	
	Weight %	Atomic Quantity	Weight %	Atomic Quantity	Weight %	Atomic Quantity
1-st	59.8		26.6		10.0	
2-nd	62.1		26.6		9.23	
Average	60.9	0.310	26.6	0.476	9.61	0.090
Interpolated to 100%	62.65	0.321	27.36	0.489	9.89	0.093

<sup>1</sup>The analysis was conducted in the laboratory of the Institute of General and Inorganic Chemistry of the Academy of Sciences of the USSR by the analyst T. P. Solovykh.

The chemical analysis of ferroplatinum reveals some very interesting features of its composition. The most salient feature is a very high content of iron exceeding all values known up to now. In connection with this, the ratio of platinum to iron in the mineral described in this work is not 1:1 as it is in the maximum contents of iron listed in the bibliographic references to the analysis of ferroplatinum, but 2:3. The considerable content of palladium also draws attention to itself. Perhaps, a part of palladium was brought about by the stannopalladinite impurity. /213

#### X-Ray Study of Ferroplatinum

In order to get a good X-ray picture of ferroplatinum, which usually has broken and blurred lines due to the malleability of the metal, we used the MIM-8 microscope which is equipped with a marking lens. With the aid of the small diamond pyramide of this lens inserted into the microscope in place of the normal lens, very fine particles were bored out from the fillings of ferroplatinum in a polished section. The latter were rolled into the ball of rubber gum with the diameter of .5 mm, photographed on the URS-55 in the RKD chamber (X-ray diffraction chamber) D-57.3 with FeK ( $\alpha$ ) radiation, and resulted in an X-ray picture with distinct and sufficiently intense lines (Figure 5). Results of the comparison of the X-ray picture of the Noril'sk ferroplatinum from a chalcopyrite vein and the X-ray picture of the Ural ferroplatinum and ferroplatinum from sections of the Noril'sk deposits (Mikheyev and others, 1961) are presented in Table 2. /214



Figure 5. X-ray Picture of Ferroplatinum.

The data of Table 2 indicate to a large extent the close relationship between the X-ray pictures of the ferroplatinum that is under study and the Ural ferroplatinum and their distinction from the X-ray picture of the Noril'sk ferroplatinum sections like the X-ray picture of the Ural ferroplatinum, the lines 200, 220, and 311 are split in two, while reflections 111 and 222 remain

nonsplit (Figure 5). V. I. Mikheyev (Mikheyev et al., 1961) explains on the basis of the theory of homology (Mikheyev, 1961) the phenomenon of splitting the lines on the X-ray picture of the Ural ferroplatinum by the tetragonalization of the cubic lattice cell which is caused by bringing into order the atoms of iron and platinum in the face-centered structure. Using the principle of homology he indexed the X-ray picture on the basis of tetragonal structure by parameters  $a = 3.867 \text{ \AA}$  and  $c = 3.735 \text{ \AA}$ , which are determined directly from reflections 200 and 002. V. I. Mikheyev also points out that the phenomenon of orderliness manifests itself not only in the splitting of lines, but also in the appearance of overstructural lines with mixed indices, such as 110, 201, 310, and 320.

Table 2: X-Ray Pictures of Noril'sk and Ural Ferroplatinum

Ferroplatinum from Chalcopyrite Vein of the Noril'sk Deposits.		Ural Ferroplatinum Mikheyev et al. (1961)		hkl	Ferroplatinum From Sections, Noril'sk Deposits, Mikheyev et al. (1961)		hkl
I	d	I	d		I	d	
2	3.73			001			
2	2.71	1	2.732	110			
5	(2.406)	1	(2.427)	111 $\beta$	2	2.45	111 $\beta$
10	2.182	8	2.198	111	6	2.23	111
2	2.09			200 $\beta$	1	2.12	200 $\beta$
1	2.01						
5	1.919	5	1.930	200	7	1.929	200
5	1.888	2	1.864	002			
1	1.817						
1	1.707	1	1.712	201	1	1.727	216
		1	1.598	211			
3	1.515						
3 III	(1.474)	2	1.473	202 $\beta$			
5	1.343	4	1.365	220	6	1.365	220
2	1.330	4	1.338	202			
3	(1.278)	3	1.282	311 $\beta$			
3	1.264						
1	1.219	1	1.224	310			
1	(1.206)				1	1.226	222 $\beta$
6	1.154	10	1.163	311	7	1.162	311
7	1.142	2	1.133	113			
4	1.114	1	1.122				
8 III	1.093	5	1.098	222	5	1.113	222
		1	1.079	320			
3	1.032			203			
5	1.015			312			

Most of the lines of the X-ray picture of ferroplatinum under study are apt to be well indexed similar to the lines of the Ural ferroplatinum on the basis of parameters  $a = 3.84 \text{ \AA}$  and  $c = 3.78 \text{ \AA}$ , which are determined by the reflections 200 and 002. The ratio of axis  $c/a = .980$  is close to the value given by A. Kussman and G. Rittberg (1950) for ferroplatinum of composition Fe-Pt- $c/a = .973$ . The fact that some of the lines cannot be indexed is evidently caused by the presence of impurities.

Thus the data of X-ray photography present justification to consider that the mineral under study is the ordered tetragonal ferroplatinum.

We consider it our pleasant duty to express our gratitude to I. V. Mikheyeva for her assistance in work.

## REFERENCES

1. Betekhtin, A. G., *Platina* [Platinum], AN SSSR Press, 1935.
2. Betekhtin, A. G., *Mineralogiya* [Mineralogy], Gosgeolizdat Press, 1950
3. Vysotskiy, N. K., "Platinum and the Areas of Its Mining. Natural Productivity Forces of USSR," *Poleznyye iskopayemyye*, No. 4, 1925.
4. Genkin, A. D., "Discovery Conditions and Specific Features of the Composition of Platinum Group Minerals in the Ores of Noril'sk Deposits," *Geologiy Rudnykh Mestorozhdeniy*, No. 6, 1959.
5. Genkin, A. D., and N. V. Korolev, "On the Methodology of Determination of Small Grains of Minerals in Ores," *Geologiy Rudnykh Mestorozhdeniy*, No. 5, 1961.
6. Maslenitskiy, I. N., "New Platinum Minerals in Sulfide Copper-Nickel Ores," *Zap. Leningr. gornogo in-ta*, Vol. 22, No. 2, 1948.
7. Mikheyev, V. I., *Gomologiya kristallov* [Crystal Homology], Gostoptekhizdat Press, 1961.
8. Mikheyev, V. I., A. I. Kalinin and E. P. Sal'dau, "X-ray Study of Platinum of the Noril'sk Deposits", *Zap. Leningrad gornogo in-ta*, Vol. 38, No. 2, 1961.
9. Kussman, A. and G. Rittberg, *G. Zeitschr. Metallkunde*, No. 41, 1950.

Translated for the National Aeronautics and Space Administration under Contract No. NASw-2037 by Techtran Corporation, P.O. Box 729, Glen Burnie, Maryland 21061, translator: E. S. Serebrennikov.